

इंटरनेट

मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”

Mazdoor Kisan Shakti Sangathan

“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 5435 (1987): General Requirements for Cold Bituminous Macadam Mixing Plants [MED 18: Construction Plant and Machinery]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE



Indian Standard

GENERAL REQUIREMENTS FOR COLD BITUMINOUS MACADAM MIXING PLANTS

(First Revision)

UDC 625.85.088

© Copyright 1987

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

GENERAL REQUIREMENTS FOR COLD BITUMINOUS MACADAM MIXING PLANTS

(First Revision)

Construction Plant and Machinery Sectional Committee, BDC 28

Chairman

MAJ-GEN J. C. SACHDEVA

Representing

Directorate General of Border Roads, New
Delhi

Members

BRIG B. V. AHUJA
BRIG SUSHIL JAGOTA } (Alternate to
Maj-Gen J. C. Sachdeva)

SHRI R. P. CHOPRA National Projects Construction Corporation Ltd,
New Delhi

SHRI O. S. GUPTA (Alternate)
CHIEF ENGINEER Punjab Irrigation & Power Department, Govern-
ment of Punjab, Chandigarh

DIRECTOR (Alternate)
CHIEF ENGINEER (ELEC) (I) Central Public Works Department, New Delhi
SUPERINTENDING ENGINEER (Alternate)

DIRECTOR (P & M) Central Water Commission, New Delhi

DEPUTY DIRECTOR (P & M) (Alternate)
DR A. K. MULICK National Council for Cement and Building
Material, New Delhi

SHRI RATTAN LAL (Alternate)
DR A. K. RAY Jessop & Company, Calcutta

SHRI A. K. MUKHERJEE (Alternate)
DR M. P. DHIR Central Road Research Institute (CSIR), New
Delhi

SHRI Y. R. PHULL (Alternate)
SHRI G. S. GOPALRAO Hindustan Construction Co Ltd, Bombay
SHRI R. V. DATYE (Alternate)

(Continued on page 2)

© Copyright 1987

BUREAU OF INDIAN STANDARDS

This publication is protected under the *Indian Copyright Act* (XIV of 1957) and reproduction in whole are in part by any means except with written permission of the publisher shall be deemed to be an infringement of copyright under the said Act.

(Continued from page 1)

<i>Members</i>	<i>Representing</i>
SHRI D. M. GUPTA	U. P. State Bridge Corporation, Lucknow
JOINT DIRECTOR (WORKS)	Ministry of Railways
JOINT DIRECTOR (CIVIL ENGG) (<i>Alternate</i>)	
SHRI Y. R. KALRA	Bhakra Beas Management Board, Chandigarh
SHRI M. L. AGGARWAL (<i>Alternate</i>)	
SHRI S. A. MENEZES	Heatly & Gresham (India) Ltd, New Delhi
SHRI P. K. MALHOTRA (<i>Alternate</i>)	
SHRI J. P. KAUSHISH	Central Building Research Institute (CSIR), Roorkee
DR S. S. WADHWA (<i>Alternate</i>)	
SHRI S. K. KELAVKAR	Marshall Sons & Co India Ltd, Madras
SHRI P. G. SURESH (<i>Alternate</i>)	
MAJ-GEN P. N. KAPOOR	Research & Development Organization (Ministry of Defence), New Delhi
SHRI S. N. SIDHANTI (<i>Alternate</i>)	
SHRI S. Y. Khan	Killick Nixon & Co Ltd, Bombay
SHRI A. MEHRA (<i>Alternate</i>)	
SHRI V. K. KHANNA	International Engineering & Construction Co, Calcutta
SHRI M. E. MADHUSUDAN	Directorate General of Technical Development, New Delhi
SHRI K. L. NANGIA (<i>Alternate</i>)	
SHRI M. NARAINASWAMY	Engineer-in-Chief's Branch, Secundrabad
SHRI H. S. DUGGAL (<i>Alternate</i>)	
SHRI T. H. PESHORI	Recondo Limited, Bombay
SHRI S. J. BASU (<i>Alternate</i>)	
SHRI T. H. PESHORI	Builder's Association of India, Bombay
BHAI TRILOCHAN SINGH (<i>Alternate</i>)	
SHRI S. S. PRAJAPATHY	Sayaji Iron & Engineering Company Private Ltd, Vadadora
SHRI NAVIN S. SHAH (<i>Alternate</i>)	
SHRI G. RAMDAS	Directorate General of Supplies & Disposals, New Delhi
SHRI I. C. KHANNA (<i>Alternate</i>)	
SHRI D. SESHAGIRI RAO	Sahayak Engineering Pvt Ltd, Hyderabad
SHRI R. C. REKHI	International Airport Authority of India, New Delhi
SHRI B. S. MATHUR (<i>Alternate</i>)	
MAJOR RAVINDRA SHARMA	Directorate of Standardization (Ministry of Defence), New Delhi
SHRI M. N. SINGH	Indian Road Construction Corporation Ltd, New Delhi
SHRI K. S. SRINIVASAN	National Buildings Organization, New Delhi
SHRI MUHER SINGH (<i>Alternate</i>)	
SHRI J. SWAMINATHAN	Bharat Earth Movers Ltd, Bangalore
DR K. APRAMEYAN (<i>Alternate I</i>)	
SHRI K. S. PADMANABHAM (<i>Alternate II</i>)	
SHRI G. VISWANATHAN	Ministry of Shipping and Transport (Roads Wing)
SHRI J. K. DUGAD (<i>Alternate</i>)	

(Continued on page 13)

Indian Standard

GENERAL REQUIREMENTS FOR COLD BITUMINOUS MACADAM MIXING PLANTS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 30 June 1987, after the draft finalized by the Construction Plant and Machinery Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 In many parts of India, rain is extended to a longer period of the year and road construction aggregates, such as crushed stone, gravel, sand, etc, are available in wet condition. Such aggregates may be mixed with a suitable bitumen emulsion to produce the desired bitumen aggregate mixture. No additives are required to coat wet stone and wet sand, if bitumen emulsion is used. Although hand-operated and small mobile power-driven mixers have been widely used in the past for mixing dry aggregates, large mixing plants equipped with devices for effective controls are used. This standard has been prepared with the object of providing guidance to proposed users and manufacturers of mixing plants and ensuring that the plant will be capable of producing bitumen emulsion aggregates mixtures of desired quality.

0.3 As a variety of combinations of ancillary equipment may be required to suit different conditions, information has to be supplied both by the user for the guidance of the manufacturer, and by the manufacturer to the prospective user.

0.4 This standard was first published in 1969. The present revision has been taken up to incorporate the modifications considered necessary as a result of experience gained during the use of this standard. In view of introduction of bitumen emulsion in the road work, it has been included in this revision and the relevant clauses have been modified.

0.4.1 Some of the provisions given in this standard are not specific so the title has been changed to General Requirements for Cold Bituminous Macadam Mixing Plants.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard lays down the requirements regarding materials, design, construction, capacity and performance criteria for cold bituminous mixing plants of continuous and batch mixing type.

2. MATERIALS

2.1 Materials used in the construction of the plant, in ancillary equipment and in the power units shall comply with the requirements of relevant Indian Standards.

3. CAPACITY

3.1 The capacity of the plant shall be denoted by the approximate output in rating when crushed aggregate (all passing 30 mm square mesh sieve and retained on 10 mm square mesh sieve) is mixed with 4 to 6 percent (by weight of aggregate) bitumen emulsion conforming to IS : 3117-1965† or IS : 8887-1978‡ at a temperature between 25 and 30°C.

3.2 In acceptance tests of the plant, the efficiency of mixing shall be controlled by the Ross Count Method (*see* Appendix A) and a Ross Count of more than 80 percent will be acceptable.

4. MOBILITY

4.1 The mixing unit of the plant shall be mobile and shall be mounted on a chassis equipped with four pneumatic wheels of adequate size with rear wheels having brakes which may also be used for parking, if desired, by the purchaser. If required, over-run brake mechanism may be provided so that the plant never over-runs the towing vehicle while going down a gradient. Ancillary equipment, such as elevator, feeder and bitumen boilers, shall be mounted on wheels or skids, if weighing more than 500 kg. The length, width and height of any section of the plant,

*Rules for rounding off numerical values (*revised*).

†Specification for bitumen emulsion for roads (anionic type).

‡Specification for bitumen emulsion for roads (cationic type).

when prepared for moving, shall preferably not exceed 6, 2.5 and 4 m respectively.

NOTE — The mixing unit of the plant, if required, may be mounted on a fully sprung chassis equipped with pneumatic tyres of adequate size, and with over-run and parking brakes.

5. POWER UNIT

5.1 The plant shall be driven by a diesel engine of adequate brake horsepower or a 3-phase squirrel-cage induction motor of adequate capacity as required. The power unit shall conform to the requirement of the relevant Indian Standard and shall be mounted in such a way that it may be readily removed for repairs and replacements.

6. REQUIREMENTS

6.1 **Safety Requirements** — The design of the plant shall minimize hazards to the operator. All gears, pulleys, chains, belts, sprockets, dangerous moving parts and parts which are subject to high operating temperature shall be well guarded and protected. Adequate and safe stairways to the mixer platform and other units shall be provided.

6.1.1 Adequate unobstructed space shall be provided on the mixing platform with easy and safe access to a location above the mixer to obtain samples of the aggregates and also in and around the truck loading space with a ladder or platform to permit easy and safe inspection of the mixture being delivered into trucks.

6.1.2 The various components shall be so designed that overloading of any part as a result of jamming is immediately relieved by breaker bolts or shear pins or similar devices such as centrifugal clutch between the engine and transmission of adequate capacity may also be provided as an alternative so that the engine is not overloaded at any time.

6.1.3 Installation of combustion devices, boilers and fuel tanks shall conform to relevant safety regulations. Effective precautions shall be taken to minimize the risk of fires resulting from spilling or overflowing of fuel or bitumen emulsion or due to any other source. Adequate precautions shall be taken while adding any type of additives and or antistripping agents.

6.2 **Maintenance Accessibility** — The design of the plant shall provide convenient accessibility to all components, sub-assemblies and parts for maintenance and repairs.

6.3 **Lubrication** — Lubrication means shall be provided for all bearings and all other moving parts requiring lubrication. Plain bearings or their shafts shall have oil or grease grooves. All lubricating nipples shall be of similar type and shall be readily accessible. Where access for lubrication

is difficult, bearings shall be such that lubrication is required as infrequently as possible or facilities for lubrication for a remote position shall be provided. Lubrication points shall be conspicuously marked to identify the lubricants and their temperature range. Chains shall be enclosed and provided with an oil bath or drip feed lubrication, wherever necessary.

6.4 Gearing — Gearing shall be designed to have ample strength and to adequately withstand wear and temperature rise. Gearing shall, as far as possible, conform to the requirements of IS : 2535-1978*. Moulded teeth may be used for pitch line speeds not exceeding 30 m/min. Keys in gear trains shall be so fitted and secured that they may not work loose.

6.5 Rotating and Fixed Shafts and Axles — Shafts and axles shall have ample rigidity and adequate bearing surfaces for their purposes. They shall, where necessary, be finished smooth.

6.6 Chain Drives — Chain drives shall be of steel bushed roller chain.

7. COMPOSITION OF PLANT

7.1 The mixing plant shall have such of the following components as may be required:

- a) Aggregate feeder;
- b) Mixer unit with elevator, if necessary, the mixer being either of the continuous or batch mixing type; and
- c) Bitumen emulsion storage unit.

8. AGGREGATE FEEDER

8.1 A single aggregate feeder of sufficient capacity may be used. The aggregate feeder shall have not less than two bins or compartments, each provided with accurate mechanical means for feeding the aggregate at a uniform and predetermined rate to the elevator or to some intermediated conveyor delivering the aggregate to the weighing or measuring equipment. The feeder shall provide for the adjustment of total and proportional feed. For smaller plants, the cold feed hopper may be directly mounted over the pugmill and discharge door opened or closed manually. The loading of the cold feed hopper may be done manually or by mechanical means.

8.2 The feeder shall be constructed generally of mild steel or of such dimensions that there is no distortion, when fully loaded.

*Specification for basic rack and modules of cylindrical gears for general engineering and heavy engineering (*second revision*).

8.3 The height of the top of the hopper above ground level in the erected plant shall not, unless so permitted by the purchaser, exceed 2.5 m. In smaller plants, where the cold aggregate hopper is fitted directly over the twin shaft pugmill, the height of the cold feed hopper shall not be more than 1.5 m from the top of the platform.

9. AGGREGATE ELEVATOR

9.1 The aggregate may be elevated to the mixer by the following:

- a) A bucket conveyor,
- b) A skip hoist, and
- c) Belt conveyor.

10. CONTROL OF BITUMEN EMULSION

10.1 Satisfactory means, by weighing, metering or volumetric measurements, shall be provided to obtain the required percentage of bitumen emulsion in the mix within a tolerance of ± 2 percent of the quantity required. Where the quantity of bitumen emulsion is controlled by metering or by volume, provision shall be made whereby the amount of bitumen emulsion delivered through the meter or bitumen emulsion bucket may be readily checked by weight. Suitable insulation for maintaining the temperature of the emulsion shall be provided.

10.1.1 If required, a pump operated by the mixer power unit shall be provided for drawing bitumen emulsion from the storage unit and maintaining the supply in continuous circulation while the plant is operating. Any other suitable arrangement for conveying bitumen emulsion to the bucket or sprayer may also be provided.

10.1.2 The requirements of pump as given in 10.1.1 shall either be driven by a flat belt through fast and loose pulleys or by some means that will include a safety device to protect the pump and the drive in the event of bitumen emulsion solidifying in the pump. A torque coupling or other arrangement may be made to prevent power being transmitted to the pump when bitumen emulsion has not attained the consistency for pumping.

11. BATCH TYPE MIXER UNIT

11.1 If required, batch type mixer unit shall include equipment for weighing or volumetric measurement of aggregate and bitumen, and a batch mixer box of the twin shaft pugmill type. In smaller mixers, volumetric measurements with a measuring hopper may be used.

11.2 Weighing Equipment — All weighing equipment shall be substantially constructed and of a design which will permit easy realignment and adjustment. Equipment shall include a means for accurately weighing the aggregate in a weigh box or hopper suspended on scales ample in size to hold a full batch without hand raking or running over. The weigh box or hopper shall be so constructed as to prevent leakage when they are closed. A weigh box that permits the segregation of aggregate sizes in the ends of the mixer shall not be used.

11.2.1 Aggregate Scales — Scales for any weigh box or hopper may be of either the beam or springless dial type and shall be of suitable design, accurate to ± 0.5 percent of the indicated load.

11.2.1.1 When scales are of the beam type, there shall be a tare beam for balancing the hopper and a separate beam for the aggregate. The beam shall have locking device designed and so located that the beam may easily be suspended or thrown into action.

11.2.1.2 Dial type scales shall be springless and shall be designed, constructed and installed in such a manner as to be free from vibration. They shall also be of such size that the numerals on the dial may be read at a distance of three metres. All dials shall be so located as to be plainly visible to the operator at all times. Pointer shall be set close to the face of the dial and shall be free from excessive parallax. The scale shall be provided with an adjustable pointer for marking the weight of the material to be weighed into the batch.

11.2.2 Bitumen Emulsion Scales — Scales for the weighing of bitumen emulsion shall conform to the requirements for aggregate scales, except that beam scales shall consist of a full capacity beam. The minimum graduation shall be not greater than 0.50 kg.

11.2.3 In the case of a small unit, volumetric measurement of both aggregates and bitumen will be permitted.

11.3 Volumetric Method of Proportioning — Volumetric method of proportioning may be provided as an alternative to weighing but in this case, accurate scales and facilities shall be provided for checking the measuring devices by weight. A hopper that permits the segregation of aggregate sizes in the ends of the mixer shall not be permitted.

11.3.1 Bitumen emulsion measuring equipment provided on the plant shall be capable of accurately measuring into each batch, the required amount of bitumen emulsion within a tolerance of ± 2 percent.

11.3.2 When a bitumen emulsion bucket is used, its capacity shall be at least 10 percent in excess of the weight of bitumen emulsion required for a one batch mix. Where spraying is resorted to, the plant shall have

a quick-closing, non-dripping, charging valve. The length of the discharge opening or spray bar shall not be less than three-fourths of the length of the mixer, it shall discharge directly into the mixer.

11.3.3 When a volumetric meter is used, the meter shall be designed and constructed so that it will automatically meter the bitumen emulsion into each batch. The dial to indicate the amount of bitumen emulsion shall have a capacity of at least 10 percent in excess of the weight or litres of bitumen emulsion required in one batch. The meter shall be constructed so that it may be locked at any dial setting and will automatically reset to this reading after the addition of bitumen emulsion to each batch. The dial shall be in full view of the mixer operator. The size and spacing of the spray bar opening shall provide a uniform application of bitumen emulsion in the full length of the mixer. The section of the bitumen emulsion flow line between the charging valve and the spray bar shall be provided with a valve, and outlet for checking and testing accuracy of the meter.

11.4 The plant shall include a mixer unit of the twin shaft pugmill type capable of producing a uniform mix when mixing the maximum rated output. The mixer unit shall be constructed as to prevent leakage of contents until the batch is discharged.

11.4.1 Mixer unit liner plates shall be wear resistant with at least 300 BHN hardness, paddle arms may be made out of cast steel and paddle tips shall be of high manganese steel or equally wear-resistant material and both shall be replaceable.

11.4.2 Unless means are provided for elevating the mixed material to a hopper or to waiting trucks, the discharge height of the mixer unit shall be not less than two metres above ground level. In the case of a smaller plant, the discharge door will be at sufficient height to allow a standard wheel barrow to easily go under it without obstruction.

11.4.3 Mixer unit shall have the following capacities:

- | | |
|------------------------------|--------------------|
| a) 6 tonnes per hour mixers | 350 kg per batch |
| b) 20 tonnes per hour mixers | 500 kg per batch |
| c) 40 tonnes per hour mixers | 1 000 kg per batch |
| d) 60 tonnes per hour mixers | 1 500 kg per batch |

12. CONTINUOUS TYPE MIXER UNIT

12.1 Synchronization of Aggregate and Bitumen Emulsion Feed — Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins or compartments and the

flow of bitumen emulsion from the meter or other proportioning device. This control shall be accomplished by interlocking mechanical means or by any positive method. The aggregate bins shall be provided with automatic controls and signal devices which will warn of low levels. The bitumen emulsion storage system shall be provided with automatic controls and signal devices which will warn of low levels of bitumen emulsion.

12.1.1 The aggregate shall be delivered to a bin having a capacity of not less than five minutes plant output. The floor of the bin shall be formed by an apron feeder which will convey the aggregate at a uniform rate through a rectangular orifice with one dimension adjustable positive mechanical adjustment and provided with a lock. An indicator shall be provided on the orifice to show the opening in centimetres. The feeder shall be equipped with a dustproof revolution counter with minimum graduation of one-tenth of a revolution.

12.2 Mixture

12.2.1 The plant shall include a continuous mixer unit of a twin shaft pugmill type capable of producing a uniform mix. The paddles shall be of a type adjustable for angular position on the shafts and reversible to retard the flow of the mix.

12.2.2 Liner plates and paddle tips shall be of high manganese steel or equally wear resistant material and shall be replaceable.

12.2.3 In order to facilitate the placing of empty trucks in position to received mixed material, a suitable arrangement shall be provided at the discharge end of the mixer unit which shall be capable of retaining mixed material during a period of one minute.

12.2.4 Unless means are provided for elevating the mixed material to a hopper or to waiting trucks, the discharge height of the mixer unit shall be not less than two metres above ground level.

12.2.5 Mixing shall continue for not less than the following distance after the addition of the bitumen emulsion:

- | | |
|------------------------------|--------|
| a) 20 tonnes per hour mixers | 1.00 m |
| b) 40 tonnes per hour mixers | 1.50 m |
| c) 60 tonnes per hour mixers | 2.00 m |

13. STORAGE UNIT FOR BITUMEN EMULSION

13.1 Storage tank capacity shall be sufficient for at least one day run. If so specified, means shall be provided for the filling of the storage tanks with packed bitumen emulsion by means that will ensure the complete

emptying of bitumen emulsion drums at a rate not less than the maximum demand of the plant.

14. FINISHING

14.1 All exposed parts of the plant shall be cleaned, treated and painted with suitable anti-corrosive protective paint conforming to the relevant Indian Standards. Electrical equipment, power units and parts subjected to high temperature shall be painted with special paint suited for the purpose.

15. MAINTENANCE TOOLS AND ACCESSORIES

15.1 A strong tool box with lock and key, containing necessary tools and accessories for normal maintenance, adjustment and lubrication of the plant together with instructions and inventory of tools and accessories shall be provided. Provisions shall be made for suitably affixing the tool box on machine.

15.1.1 *Instruction Manual* — An instruction manual for the operation of the plant indicating the conditions to be followed to ensure a uniform flow of the proper aggregate sizes, the calibrating and setting up of cold aggregate, feeder gate, etc, shall be provided.

16. MARKING

16.1 *Instruction Plate* — Each unit of the plant shall be fitted with instruction plates including warnings and cautions, suitably located, describing any special or important procedures to be followed in operating and servicing the plant.

16.2 *Marking Plate* — The plant shall have an identification plate permanently affixed to it with the following particulars conspicuously marked on it.

- a) Manufacturer's name or trade-mark,
- b) Manufacturer's reference number of plant,
- c) Capacity of plant (*see* 3),
- d) Type of mixer (*see* 11 and 12),
- e) Type and rating of power units, and
- f) Year of manufacture.

APPENDIX A

(Clause 3.2)

ROSS COUNT METHOD OF CHECKING MIXING EFFICIENCY

A-1. DETAILS OF THE METHOD

A-1.1 The Ross Count Method of checking mixing efficiency is based on a study started in 1955 by the Barber-Greene Company. It is described in the proceedings of the Association of Asphalt Paving Technologists, Vol 28 (1955) and Vol 30 (1961). The method consists visually examining mixed material retained on a 10 mm screen and counting the relative number of coated and uncoated particles. Any particle not completely coated is classified as uncoated even though only a speck remains uncoated.

A-1.2 For the purpose of this specification, the Ross Count will be the percentage of coated particles in the average of three samples each having uncompacted volume of approximately 0.03 cm.

(Continued from page 2)

Members

SHRI G. RAMAN,
Director (Civ Engg)

Representing

Director General, BIS (*Ex-officio Member*)

Secretary

SHRI HEMANT KUMAR
Deputy Director (Civ Engg), BIS

Panel for Asphalt Mixing and Paving Plants, BDC 28/P 3

Convener

SHRI G. VISWANATHAN

Ministry of Shipping and Transport

Members

SHRI J. K. DUGAD (<i>Alternate to</i> Shri G. Viswanathan)	
DR M. P. DHIR	Central Road Research Institute (CSIR), New Delhi
SHRI S. K. KELAVKAR	Marshall Sons & Co India Ltd, Madras
SHRI V. K. KHANNA	International Engineering & Construction Company, Calcutta
COL R. K. MATHUR	Indian Road Construction Corporation Ltd, New Delhi
SHRI S. A. MENEZES	Heatly & Gresham (India) Ltd, New Delhi
SHRI P. K. MALHOTRA (<i>Alternate</i>)	
SHRI R. K. MITTAL	Directorate General of Border Roads, New Delhi
SHRI D. P. KAPILA (<i>Alternate</i>)	
SHRI A. J. PATEL	Millars, Bombay
SHRI T. H. PESHORI	Recondo Limited, Bombay
SHRI S. J. BASU (<i>Alternate</i>)	
SHRI S. S. PRAJAPATHY	Sayaji Iron & Engineering Company Private Ltd, Vadodara
SHRI N. S. SHAH (<i>Alternate</i>)	
SHRI D. SESHAGIRI RAO	Sahayak Engineering Pvt Ltd, Hyderabad

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s ²
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m ²
Frequency	hertz	Hz	1 Hz = 1 c/s (s ⁻¹)
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m ²

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002

Telephones : 3 31 01 31. 3 31 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices:

Telephone

*Western : Manakalaya, E9 MIDC, Marol, Andheri (East), 6 32 92 95
BOMBAY 400093

†Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, 36 24 99
Maniktola, CALCUTTA 700054

Northern : SCO 445-446, Sector 35-C, { 2 18 43
CHANDIGARH 160036 { 3 16 41

Southern : C. I. T. Campus, MADRAS 600113 { 41 24 42
{ 41 25 19
{ 41 29 16

Branch Offices:

'Pushpak', Nurmohamed Shaikh Marg, Khanpur, { 2 63 48
AHMADABAD 380001 { 2 63 49

'F' Block, Unity Bldg, Narasimharaja Square, 22 48 05
BANGALORE 560002

Gangotri Complex, 5th Floor, Bhadbhada Road, T. T. Nagar, 6 67 16
BHOPAL 462003

Plot No. 82/83, Lewis Road, BHUBANESHWAR 751002 5 36 27

53/5, Ward No. 29, R. G. Barua Road, —
5th Bylane, GUWAHATI 781003

5-8-56C, L. N. Gupta Marg (Nampally Station Road), 23 10 83
HYDERABAD 500001

R14 Yudhister Marg, C Scheme, JAIPUR 302005 { 6 34 71
{ 6 98 32

117/418B Sarvodaya Nagar, KANPUR 208005 { 21 68 76
{ 21 82 92

Patilputra Industrial Estate, PATNA 800013 6 23 05

Hantex Bldg (2nd Floor), Rly Station Road, 7 66 37
TRIVANDRUM 695001

Inspection Offices (With Sale Point):

Pushpanjali, 205-A West High Court Road, 2 51 71
Bharampeth Extension, NAGPUR 440010

Institution of Engineers (India) Building, 1332 Shivaji Nagar, 5 24 35
PUNE 411005

*Sales Office in Bombay is at Novelty Chambers, Grant Road, 89 65 28
Bombay 400007

†Sales Office in Calcutta is at 5 Chowringhee Approach P. O. Princep 27 68 00
Street, Calcutta 700072